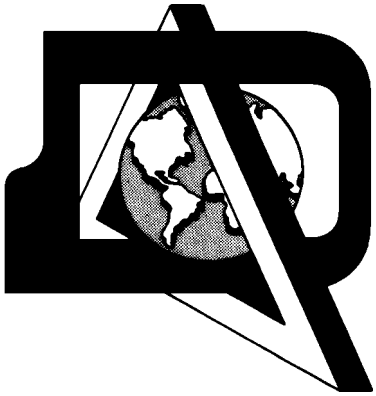
SGI01
Small Graphics
LCD Interface
User's Manual



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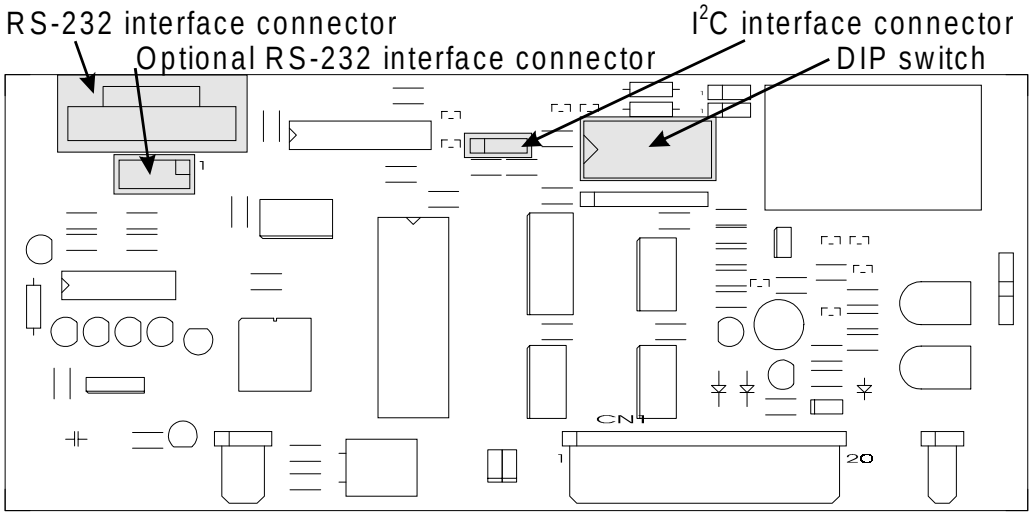
1. Introduction

The SGI01 card is a serial interface card designed to control a wide range of Densitron small graphic Liquid Crystal Display (LCDs max 256x256 pixels) modules. It has been designed to ease the implementation of an LCD screen interface whilst maximizing the number of features and functions. It has two user selectable interfaces; an RS-232 and an I^2C interface for simple interfacing to the host system. An extensive set of standard graphic drawing instruction is also included as well as a useful set of text fonts and character attributes. The instruction set allow the user to draw complicated graphics using a basic set of drawing instructions, such as lines, circles. boxes, area-fill and bit-mapped graphics.

The SGI01 supports three different LCD Graphics Controllers, namely the T6963, HD61830 and HD61202. The SGI01 provides all the necessary signals and voltages to interface to most LCD modules using either of these three controller chips.

2. Interface

There are two interfaces on the SGI01 card: the RS-232 and the I^2C interface. They are DIP switch selectable. The location of the DIP switch, the RS-232 interface connector and the I^2C interface connector is shown in the following picture:



Dipswitch	Description
1xxx xxx1	Serial line is used
0xxx xxx1	I²C interface is used

If SW1-1 is off then the RS-232 interface is used, if SW1-1 is on then the I^2C interface is used. SW1-2 - SW1-4 determines the baud rate or the I^2C address.

2.1. RS-232 interface

The RS-232 interface can receive and transmit and uses the DSR and DTR signals for hardware handshake.

DTR is used to control the input data flow of the SGI01. DTR is set if less than third of the input FIFO is used. DTR is cleared if there are less than third of the input FIFO is free. The host should suspend transmission when DTR is cleared.

DSR is used the control the output data flow of the SGI01. When DSR is cleared then the SGI01 card does not try to send.

The pinout of the RS-232 interface connector is the following:

Number	Name	Description
2	RxD	Receive data
3	TxD	Transmit data
4	DTR	Input flow control signal
5	GND	Ground
6	DSR	Output flow control signal

The format is 8 bit, no parity, one stop bit. The baud rate is DIP switch selectable.

Dipswitch	Description
1000 0xx1	150 baud serial line
1001 0xx1	300 baud serial line
1010 0xx1	600 baud serial line
1011 0xx1	1200 baud serial line
1100 0xx1	2400 baud serial line
1101 0xx1	4800 baud serial line
1110 0xx1	19200 baud serial line
1111 0xx1	9600 baud serial line
1000 1xx1	38400 baud serial line
1001 1xx1	57600 baud serial line
1010 1xx1	115200 baud serial line

2.2. I²C interface

The I²C bus is a 2-way, 2-line communication between different ICs or modules. The two lines are a serial data line (SDA) and a serial clock line (SCL). Both lines must be connected to a positive power supply via a pull-up resistor. Data transfer may be initiated only when the bus is not busy.

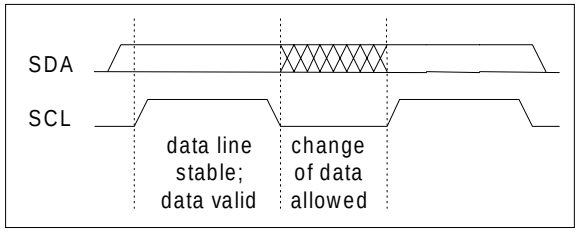
The pinout of the I²C interface connector of the SGI01 card is the following:

Number	Name	Description
1	+5V	Power supply
2	SDA	Serial data
3	SCL	Serial clock
4	GND	Ground

The pull-up resistors are R14 and R15. J15 and J16 jumpers allow disconnecting the pull-up resistors.

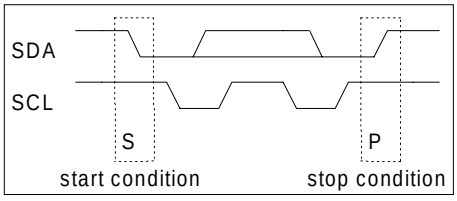
2.2.1. Bit Transfer

One data bit is transferred during each clock pulse. The data on SDA line must remain stable during the HIGH period of the clock pulse as changes in the data line at this time will be interpreted as control signals.



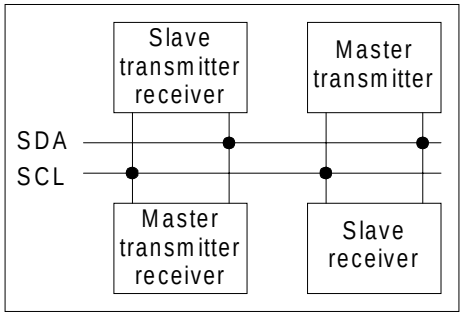
2.2.2. Start and Stop Conditions

Both data and clock lines remain HIGH when the bus is not busy. A HIGH-to-LOW transition of the data line, while the clock is HIGH is defined as the start condition (S). A LOW-to-HIGH transition of the data line while the clock is HIGH is defined as the stop condition (P).



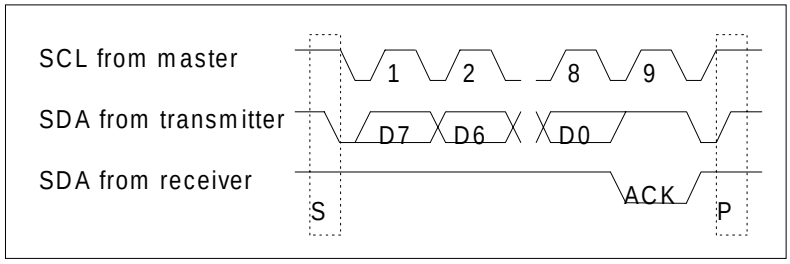
2.2.3. System configuration

Various devices can be connected to a small area network as shown in the figure. A device generating a message is the "transmitter", a device receiving a message is the "receiver". The device that controls the message is the "master" and devices controlled by the "master" are the "slaves". The SGI01 card can work in slave transmitter and receiver mode.



2.2.4. Acknowledge

The number of data bytes transferred between the start and stop conditions from transmitter to receiver is not limited. Each byte is followed by one acknowledge bit. The acknowledge bit is a HIGH level put on the bus by the transmitter whereas the master generates an extra acknowledge related clock pulse. The device that acknowledges has to pull down the SDA line during the acknowledge clock pulse, so that the SDA line is stable LOW during the HIGH period of the acknowledge related clock pulse.



2.2.5. Timing Specification

The SGI01 I^2C interface operates only in high-speed mode. See I^2C-bus Specification, Signetics, March 1989 or some other Phillips/Signetics catalogue for details.

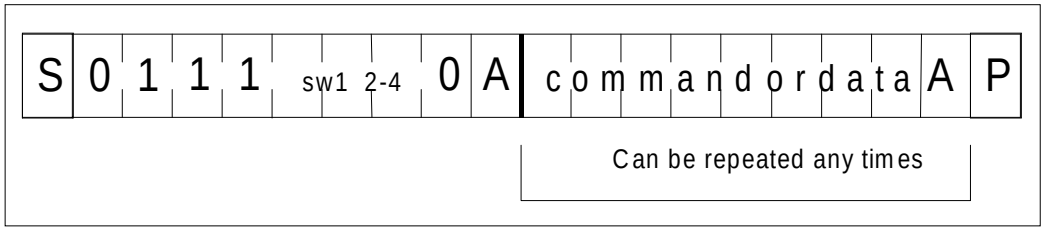
2.2.6. Addressing

Before any data is transmitted on the I^2C bus, the device which should respond is addressed first. The addressing is always done with the first byte transmitted after the start condition.

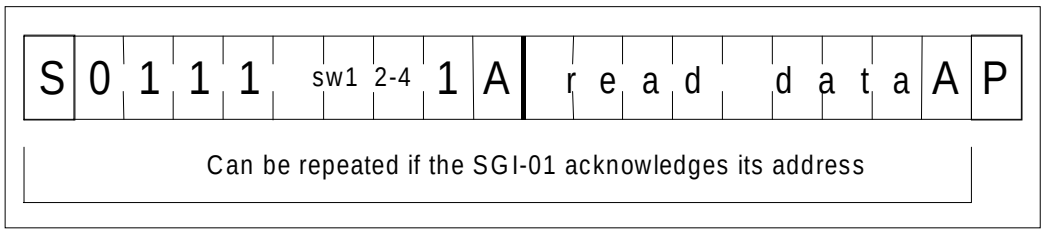
The upper 4 bits of the SGI01 card is always 0111B. Three other bits are defined by the SW1-2 - SW1-4 DIP switches, and the less significant bit determines the read or write operation. The resulting addresses are in the following table.

Dipswitch	Description
0000 xxx1	I²C write address 70H, read address 71H
0001 xxx1	I²C write address 72H, read address 73H
0010 xxx1	I²C write address 74H, read address 75H
0011 xxx1	I²C write address 76H, read address 77H
0100 xxx1	I²C write address 78H, read address 79H
0101 xxx1	I²C write address 7AH, read address 7BH
0110 xxx1	I²C write address 7CH, read address 7DH
0111 xxx1	I²C write address 7EH, read address 7FH

The SGI01 always acknowledges its write address. Then the master can send any number of command and data bytes. The SGI01 will acknowledge each data bytes that it can receive. If the input FIFO of the SGI01 is full then the SGI01 will not acknowledge that byte. Then the master either keep repeating the byte until it is acknowledged or generate a stop condition.

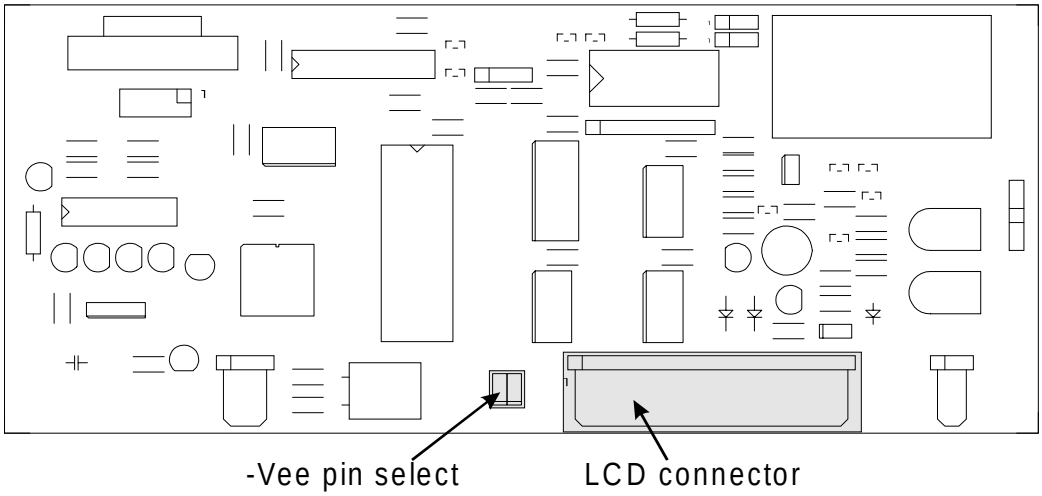


The SGI01 acknowledges its read address only if it has anything to send. If the SGI01 acknowledged the read address then the master can receive one data byte, generate an acknowledge and either a repeated start condition or a stop condition. To read the next byte the master must address the SGI01 again. The SGI01 does not check the acknowledge at the and of the data byte.

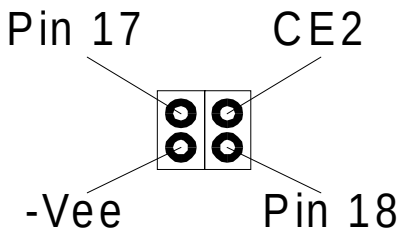


3. LCD connection

The SGI01 can control LCDs with built-in T6963, HD61830 or HD61202 controller IC. LCDs with built-in controller are connected to CN1 connector of SGI01:



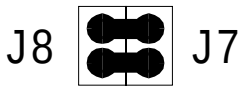
J7-J8 jumpers select the function of pin 17 and 18:



Check these jumper settings carefully, because connecting -VEE incorrectly will destroy both the LCD and SGI01.

3.1. Connecting LCDs with built-in T6963

To connect an LCD with built-in T6963 set J7-J8 jumper the following way:



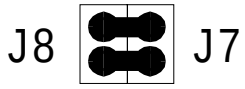
The pin assignment of CN1 20-way connector is usually identical with most of LCDs with on-board T6963.

Number	Name	Description
1	GND	Logical ground
2	VCC	Power supply for LCD driving
3	VO	Operating voltage for LCD driving
4	C/-D	Command / data select
5	-WR	Write signal
6	-RD	Read signal
7	D0	Data input/output 0
8	D1	Data input/output 1
9	D2	Data input/output 2
10	D3	Data input/output 3
11	D4	Data input/output 4
12	D5	Data input/output 5
13	D6	Data input/output 6
14	D7	Data input/output 7
15	-CE	Chip enable
16	-RESET	Controller reset
17	(MD2)	Columns select on certain type of LCDs (Driven low here)
18	-VEE	Power supply for LCD driving
19	(FS1)	Font select in certain type of LCDs (Connected to GND here)
20	NC	Not connected

Please check the connection carefully. Some LCD require -VEE on pin 17. Connecting -VEE to any other pins will destroy both the LCD and SGI01.

3.2. Connecting LCDs with built in HD61830

To connect an LCD with built-in T6963 set J7-J8 jumper the following way:



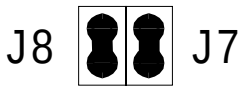
The pin assignment of CN1 20-way connector is usually identical with most of LCDs with on-board HD61830, though a few signal names are different.

Number	Name	Description
1	GND	Logical ground
2	VCC	Power supply for LCD driving
3	VO	Operating voltage for LCD driving
4	RS	Register select
5	R/-W	Read/write signal
6	E	Enable
7	D0	Data input/output 0
8	D1	Data input/output 1
9	D2	Data input/output 2
10	D3	Data input/output 3
11	D4	Data input/output 4
12	D5	Data input/output 5
13	D6	Data input/output 6
14	D7	Data input/output 7
15	-CE	Chip enable
16	-RESET	Controller reset
17	NC	Not used (driven low)
18	-VEE	Power supply for LCD driving
19	NC	Not used (GND)
20	NC	Not connected

Please check the connection carefully. Some LCD require -VEE on pin 17. Connecting -VEE to any other pins will destroy both the LCD and SGI01.

3.3. Connecting LCDs with built in HD61202

To connect an LCD with built-in T61202 set J7-J8 jumper the following way:



The pin assignment of CN1 20-way connector is usually identical with most of LCDs with on-board HD61202, though a few signal names are different.

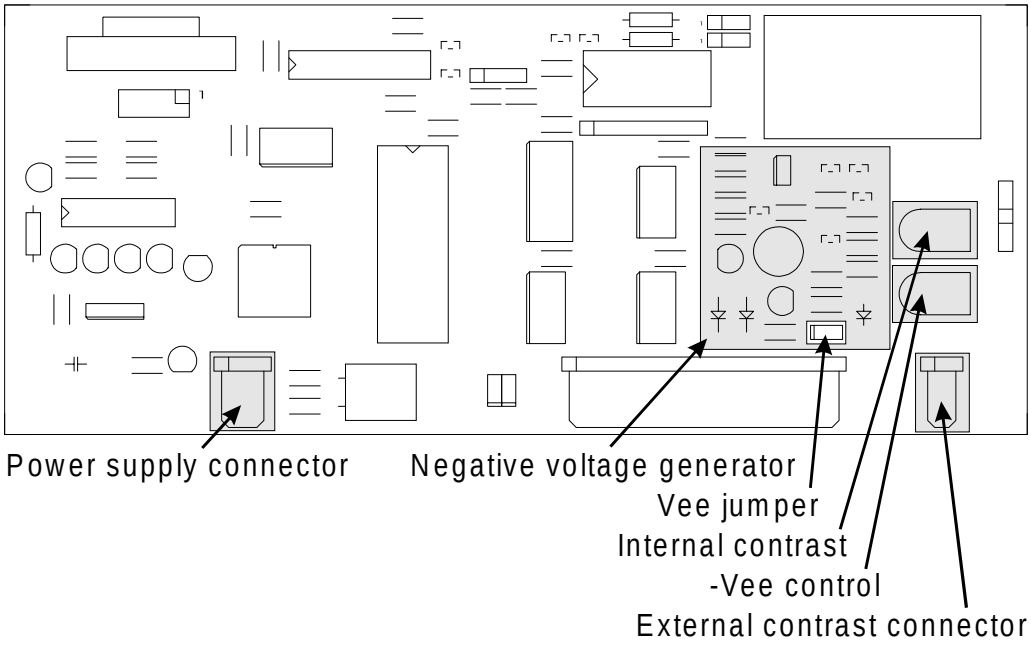
Number	Name	Description
1	GND	Logical ground
2	VCC	Power supply for LCD driving
3	VO	Operating voltage for LCD driving
4	RS	Register select
5	R/-W	Read/write signal
6	E	Enable
7	DB0	Data input/output 0
8	DB1	Data input/output 1
9	DB2	Data input/output 2
10	DB3	Data input/output 3
11	DB4	Data input/output 4
12	DB5	Data input/output 5
13	DB6	Data input/output 6
14	DB7	Data input/output 7
15	-CS1	Chip select 1
16	-RESET	Controller reset
17	**-VEE**	**Power supply for LCD driving**
18	-CS2	Chip select 2
19	NC	Not used (GND)
20	NC	Not connected

Please check the connection carefully. Some LCD require -VEE on pin 18. Connecting -VEE to any other pins will destroy both the LCD and SGI01.

3.4. Power supplies and contrast control

The SGI01 requires a single +5V power supply. Its current consumption without backlight and -VEE load is less than 50 mA. The SGI01 card has a negative voltage generator on-board which can provide the -VEE for the LCD. The value of the -VEE is trimmer settable between -5V and -20V. The total load of the inverter must not exceed 400 mW. If this is not enough it is possible to use external supply.

The following picture shows the location of the -VEE inverter, the contrast and the -VEE trimmer, and the related jumpers and connectors.



The pinout of the power connector is the following:

No	Name	Description
1	-VEE	LCD power supply
2	VO	Operating (contrast) voltage
3	+5V	Logic power supply for SGI01 and LCD
4	GND	Ground

To use the internal -VEE supply leave J1 jumper connected and set the proper -VEE voltage using P1 potentiometer. You can measure the -VEE on the power connector (CN4) between pins 1 and 4. Always check -VEE before connecting the LCD because **incorrect -VEE may damage the LCD!**

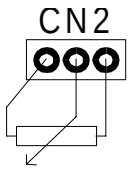
To use external -VEE supply **remove** J1 jumper, and connect the external -VEE to CN4 power connector.

There are three ways of controlling the contrast (operating) voltage of the LCD. There is a trimmer on the SGI01 card, it is possible to connect an

external contrast potentiometer or VO can be supplied and controlled externally.

To use an external contrast control connect a 10kΩ-20kΩ potentiometer to CN2 connector as it is shown in the picture on the right. Then leave P2 in center position or remove it.

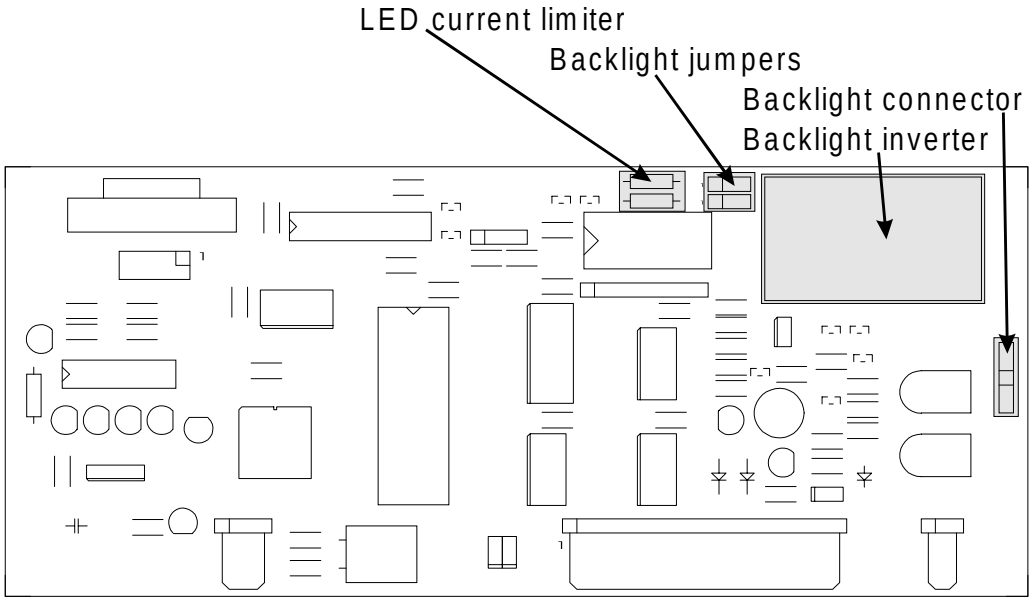
To use external VO control connect VO to pin 2 of the power connector (CN4) and leave P2 in center position or remove it.



Potmeter

3.5. Backlights

It is possible to use either LED backlight or an optional backlight inverter type DAS5V7, DAS5V10, DAS5V13 or DAS5V14. The place for the backlight inverter, the backlight connector and the related jumpers are shown on the following picture:



J2 and J3 jumpers are used to select the backlight.

Jumper	Description
	LED backlight is used
	Backlight inverter is used

The polarity of CN5 backlight connector if LED backlight is used is shown in the picture to the right.

The LED current is limited by the R10, R18 current limiting resistors (2x4.7Ω 1W). R10, R18 can be changed if necessary, but the sum of them must be greater then 6Ω 2W.

Backlight

4. Software description

The commands of the SGI01 consist of a letter followed by various parameters. The very first command sent to the SGI01 must be a DefineLCD command.

There are a set of examples in the following sections to help use the SGI01.

The encoding of the examples is the following: The codes are in double quotes ("") separated by space ( ) characters. A single letter denotes its ASCII code, two consecutive hexadecimal number denotes the hexadecimal code.

4.1. DefineLCD command

Syntax: A (LCD type) (LCD subtype) (size X low) (size X high) (size Y low) (size Y high)

The DefineLCD command defines the configuration of the SGI01 card and the connected LCD. The command sequence is seven bytes long. The first byte is the command code "A". The second byte defines the controller type:

Controller type	Code
External T6363	1
External HD61830	2
External HD61202	3

The third byte defines the LCD subtype. The meaning depends on the LCD controller type:

Controller	LCD subtype description
T6963	D7=1/0, Dual/single screen; D6-D0=Character width
HD61830	D7=1/0, Dual/single screen; D6-D0=Character width
HD61202	Not used

The last four bytes define the LCD X and Y size.

Example 1:

The configuration code sequence required for initializing a 240x64 single screen LCD with external T6963 controller is the following:

"A 01 06 F0 00 40 00"

In which "A" is the command code, "00" means the optional T6963 controller on the SGI01 card, "06" is the character width, "F0 00"=240 is the X size, and "40 00"=64 is the Y size.

Example 2:

The configuration code sequence required for initializing a 128x64 single screen LCD with on-board HD61202 is the following:

"A 03 08 80 00 40 00"

In which "A" is the command code, "03" means the LCD with on-board HD61202 controller, "08" is no used, "80 00"=128 is the X size, and "40 00"=64 is the Y size.

Example 3:

The configuration code sequence required for initializing a 240x64 dual screen LCD with on-board HD61830 is the following:

"A 02 18 F0 00 40 00"

In which "A" is the command code, "03" means the LCD with on-board HD61202 controller, "18" is the character width and the dual screen code, "F0 00"=240 is the X size, and "40 00"=64 is the Y size. If possible program character with to 8 pixels, because it is faster and use the memory more efficiently.

4.2. SetMode command

`Syntax: B (mode)`

This command determines how the new pixel value replaces the old one. The new value can overwrite the old one (COPY mode) or the result can be the XOR, OR or AND relation of the old pixel and the new one. SetMode affects all the other commands including FillScreen. The command is two bytes long. The first byte is the command code "B" and the second byte is the mode:

Code	Description
0	COPY mode: The new value overwrites the old one.
1	AND mode: The new pixel will be the AND combination of the old one and the new one
2	OR mode: The new pixel will be the OR combination of the old one and the new one
3	XOR mode: The new pixel will be the XOR combination of the old one and the new one

The use of the SetMode command is best illustrated in the examples of the FillScreen command.

4.3. SetColor command

Syntax: C (color)

SetColor command defines the drawing color for all the other instructions. The command is two bytes long. The command code "C" is followed by the color code:

Code	Color description
0	Background color (Light gray on transflective LCDs)
1	Foreground color (Dark gray on transflective LCDs)

The use of the SetColor command is best illustrated in the examples of the FillScreen command.

4.4. MoveTo command

Syntax: D (X low) (X high) (Y low) (Y high)

MoveTo is the most frequently used command. It sets the cursor position. The command is five bytes long. The command code is "D" followed by the X and the Y coordinates in the following order: (X low) (X high) (Y low) (Y high). The coordinates of the top left corner of the LCD screen are (0,0).

Example 4:

The following code sequence moves the cursor to home position:

"D 00 00 00 00"

where "D" is the command code, "00 00"=0 is the X, and "00 00"=0 is the Y coordinate.

4.5. MoveRel command

Syntax: Y (ΔX low) (ΔX high) (ΔY low) (ΔY high)

MoveRel is similar to MoveTo but the new cursor position is relative to the current one. The command code is "Y" followed by the relative X and the Y coordinates in the following order: (ΔX low) (ΔX high) (ΔY low) (ΔY high).

Example 5:

The following code sequence moves the cursor in X direction by 5 pixels:

"Y 05 00 00 00"

where "Y" is the command code, "05 00"=0 is the relative X, and "00 00"=0 is the relative Y coordinate.

4.6. SetBacklight command

Syntax: E (on/off)

SetBacklight command is used for switching on or off the backlight. The command is two bytes long. The command code is "E". followed by a parameter byte which is 1 for switching on, and 0 for switching off the backlight.

Example 6:

The following command is used for switching on the backlight:

"E 01"

4.7. FillScreen command

Syntax: F

The FillScreen command is used for clearing, setting and inverting the entire screen. This command has no parameters. The command code is "F".

Example 7:

The following code sequence inverts the screen:

"B 03 C 01 F"

where "B 03" sets XOR mode, "C 01" sets foreground color and "F" inverts the screen.

4.8. PutPixel command

Syntax: G

PutPixel sets, resets or inverts one point on the screen, depending on the mode and color settings. The command has no parameters. The command code is "G".

Example 8:

The following code sequence sets point (5,10) on the LCD screen:

"B 00 C 01 D 05 00 0A 00 G"

where "B 00" sets COPY mode, "C 01" sets the drawing color to foreground color, "D 05 00 0A 00" moves the cursor to (5,10) point and "G" sets the pixel.

4.9. GetPixel command

Syntax: H

Using GetPixel command is a simple way of reading back the data displayed on the LCD. The command has no parameters. The command code is "H". The SGI01 returns the value of the pixel under the cursor (1 for foreground, 0 for background color).

Example 9:

The following code sequence reads back the value of (10,13):

"D 0A 00 0D 00 H"

4.10. LineTo command

Syntax: I (X low) (X high) (Y low) (Y high)

Draws a line from the current cursor position to (X,Y) and moves the cursor to (X,Y) excluding the starting point. The command is five bytes long. The command code "I" is followed by the new X and Y coordinates: I (X low) (X high) (Y low) (Y high).

Example 10:

The following code sequence draws the two diagonals of a 240x64 LCD:

"D 00 00 00 00 G I EF 00 3F 00 D 00 00 3F 00 G I EF 00 00 00"

where "D 00 00 00 00" moves the cursor to (0,0) point, "I EF 00 3F 00" draws a line to (239,63), "D 00 00 3F 00" moves the cursor to (0,63) and "I EF 00 00 00" draws a line to (239,0). The color and the mode settings affect the result.

4.11. LineRel command

Syntax: Z (ΔX low) (ΔX high) (ΔY low) (ΔY high)

LineRel is similar to LineTo but the line end position is relative to the cursor position. The command code is "Z" followed by the relative X and the Y coordinates in the following order: (ΔX low) (ΔX high) (ΔY low) (ΔY high). The command is five bytes long. The command code "Z" is followed by the new relative X and Y coordinates.

Example 11:

The following code sequence draws a triangle:

"D 00 00 00 00 Z 00 00 20 00 Z 20 00 E0 FF Z E0 FF 00 00"

where "D 00 00 00 00" moves the cursor to (0,0) point, "Z 00 00 20 00" draws a line to (0,32), "Z 20 00 E0 FF" draws a line to (32,0) and "Z E0 FF 00 00" draws a line to (32,0). The color and the mode settings affect the result.

4.12. Rectangle command

Syntax: J (X low) (X high) (Y low) (Y high)

Rectangle command draws the outline of a rectangle. The top left corner of the rectangle is the cursor position, the coordinates of the bottom right corners is (X,Y) is defined in the command. After drawing the rectangle the cursor is moved to the bottom right corner. The command if five bytes long. The command code "J" is followed by the new X and Y coordinates: J (X low) (X high) (Y low) (Y high).

Example 12:

The following code sequence draws a double lined frame to the 240x64 LCD:

"D 00 00 00 00 J EF 00 3F 00 D 02 00 02 00 J ED 00 3D 00"

where "D 00 00 00 00" moves the cursor position to (0,0), "J EF 00 3F 00" draws the outer rectangle, "D 02 00 02 00" moves the cursor to (2,2) and "J ED 00 3D 00" draws the inner rectangle. Note that the actual result depends on the color and mode settings.

4.13. FillRectangle command

Syntax: K (X low) (X high) (Y low) (Y high)

FillRectangle command is similar to Rectangle command but it fills the inside of the rectangle with the current drawing color. This command is also five bytes long. The command code "K" is followed by the new X and Y coordinates: K (X low) (X high) (Y low) (Y high).

Example 13:

The following code sequence inverts the area inside of the (0,2) (10,10) rectangle:

"B 03 C 01 D 00 00 02 00 K 0A 00 0A 00"

where "B 03" sets XOR mode, "C 01" sets foreground color, "D 00 00 02 00" moves the cursor position to (0,2) and "K 0A 00 0A 00" inverts the rectangle.

4.14. Circle command

Syntax: L (Radius low) (Radius high)

Circle command draws a circle on the screen. The center is the current cursor position, the radius is the parameter of the command. The radius, like everything on screen, is measured in pixels. The cursor position remains unchanged. The command is three bytes long. The command code "L" is followed by the radius: L (Radius low) (Radius high).

Example 14:

The following code sequence draws a small circle at the center of the 240x64 LCD screen:

"D 78 00 20 00 L 0A 00"

where "D 78 00 20 00" moves the cursor to the center of the screen and "L 0A 00" draws a small circle. Note that the actual result depends on the color and mode settings.

4.15. FillCircle command

Syntax: M (Radius low) (Radius high)

FillCircle command is similar to Circle command but it fills the circle. This command is also three bytes long: The command code "M" is followed by the radius: M (Radius low) (Radius high).

Example 15:

The following code sequence draws a small filled circle at the center of the 240x64 LCD screen:

"D 78 00 20 00 M 0A 00"

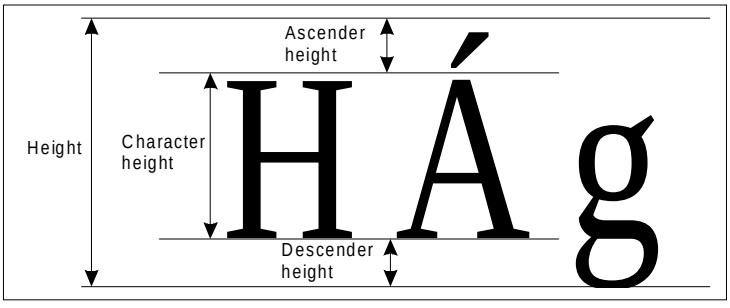
where "D 78 00 20 00" moves the cursor to the center of the screen and "M 0A 00" draws a small filled circle. Note that the actual result depends on the color and mode settings.

4.16. SelectFont command

Syntax: Q (font code)

The strongest feature of the SGI01 is the superb text handling capability. The following table shows the available fonts. The SelectFont command is two bytes long. The command code "Q" is followed by the font code.

Font name	Height	Character height	Ascender height	Descender height	Average width	Example	Code
Small 6x8	8	7	0	1	6	Text	"00"
Small 8x8	8	7	0	1	8	**Text**	"01"
Serif	10	6	2	2	4	TEXT	"10"
Serif	11	7	2	2	5	TEXT	"11"
Serif	13	9	2	2	5	TEXT	"12"
Serif	16	10	3	3	7	TEXT	"13"
Serif	20	13	3	4	8	TEXT	"14"
Sans Serif	10	6	2	2	4	TEXT	"20"
Sans Serif	11	7	2	2	5	TEXT	"21"
Sans Serif	13	9	2	2	5	TEXT	"22"
Sans Serif	16	10	3	3	7	TEXT	"23"
Sans Serif	20	13	3	4	8	TEXT	"24"
Monospace	10	6	2	2	4	TEXT	"30"
Monospace	11	7	2	2	5	TEXT	"31"
Monospace	13	9	2	2	5	TEXT	"32"
Monospace	16	10	3	3	7	TEXT	"33"



In the table *Font name* is a symbolic name used in this documentation for reference. *Height* is the total height of the character font matrix in pixel. *Character height* is the height of the letter "H" in pixels. *Ascender height* is the place above the uppercase character used for accents and row separation. (Note that there are no accented characters in the code table. Accents could be drawn by LineTo or PutBitmap commands). *Descender height* is the height below letters, used by "g", "y" etc. characters. *Average width* is the average width of the proportional fonts (Serifs and Sans Serifs) and the exact width of the monospaced fonts (Small and Monospace).

4.17. SetTextAttribute command

Syntax: R (attribute code)

Attributes can change the appearance of the character. The following table shows the possible attributes and their effect. BoldX is quite spectacular with most of the fonts, except for Small 6x8 and Small 8x8 fonts. The use of BoldY and Bold is more limited to the larger fonts. The quality of the italic characters are quite low due to the low resolution (compared to laser printers) of the LCD screen.

The SetTextAttribute command is two bytes long. The command code "R" is followed by the attribute code. The table shows the attributes in groups. The code of one item from each group can be ORed.

Attribute name	Example	Code
BoldX	Text	**"20"**
BoldY	Text	**"40"**
Bold	Text	**"60"**
Italic	*Text*	**"10"**
Underline	Text	**"08"**
Right	Text	**"00"**
Left	Text	**"01"**
Down	Text	**"02"**
Up	Text	**"03"**
Mirror	Text	**"04"**

4.18. PutChar command

Syntax: S (character code)

PutChar is the simpler of the two character writing commands. It can display only one character using the specified font and attributes. The command is two bytes long. The character code "S" is followed by the character code. The valid character codes are in Appendix B. The cursor position is the top left corner of the character. After writing the character the cursor moves left by the character width. Write mode and color settings affect the resulting image in the usual way.

Example 16:

The following code sequence writes a large bold underlined Serif "A" to the top left corner of the LCD:

"D 00 00 00 00 B 01 C 01 Q 14 R 68 S A"

where "D 00 00 00 00" moves the cursor to the top left corner of the screen, "B 01 C 01" sets OR mode and selects foreground color, "Q 14" selects the largest Serif font, "R 68" sets bold and underline, and "S A" writes the character.

4.19. PutText command

Syntax: T <string> (00)

PutText is the more widely used character writing command. It can write any number of characters, possibly in multiple lines. This is a variable length command. The command code "T" is followed by the character string. The string can contain any number of valid ASCII characters (see Appendix B), "0D" codes for carriage return and "0A" for line feed. The string and the command is terminated by "00".

Example 17:

The following code sequence writes the text "Trixel" upside down to the LCD using 16 pixel high Sans Serif with BoldX attribute:

"D 64 00 20 00 B 01 C 01 Q 23 R 21 T T r i x e l 00"

*where "D 64 00 20 00" moves the cursor to (100,32) point, "B 01 C 01" sets OR mode and selects foreground color, "**Q** 23" selects the 16 pixel high Sans Serif font, "R 68" sets BoldX and orientation, and "T T r i x e l" writes the string and "00" terminates the string.*

4.20. GetStringWidth command

Syntax: U <string> (00)

GetStringWidth command is used in conjunction with proportional spaced character fonts and PutText command. It returns the overall width of a character string. The format of the command is similar to PutText command. The command code "U" is followed by a "00" terminated string. The SGI01 returns the with of the string in pixel in two bytes (low byte first). Note that the string width varies with the selected font and attributes.

Example 18:

The following code sequence determines the width of the string "Trixel":

"U T r i x e l 00"

The returned value can be used to justify the string properly.

4.21. PutBitmap command

Syntax: V (X size low) (X size hi) (Y size low) (Y size hi) <image>

Complex images such as symbols and logos are most easily displayed by the PutBitmap command.

PutBitmap is a variable length command. The command code "V" is followed by the X and the Y size of the bitmap then the image bytes: V (X size low) (X size high) (Y size low) (Y size high) image bytes. The coding is shown on the picture. The first digit is the byte number, and the second digit is the bit number.

0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.0	1.7	1.6	1.5	1.4
2.7	2.6	2.5	2.4	2.3	2.2	2.1	2.0	3.7	3.6	3.5	3.4
4.7	4.6	4.5	4.4	4.3	4.2	4.1	4.0	5.7	5.6	5.5	5.4
6.7	6.6	6.5	6.4	6.3	6.2	6.1	6.0	7.7	7.6	7.5	7.4
8.7	8.6	8.5	8.4	8.3	8.2	8.1	8.0	9.7	9.6	9.5	9.4
10.7	10.6	10.5	10.4	10.3	10.2	10.1	10.0	11.7	11.6	11.5	11.4
12.7	12.6	12.5	12.4	12.3	12.2	12.1	12.0	13.7	13.6	13.5	13.4
14.7	14.6	14.5	14.4	14.3	14.2	14.1	14.0	15.7	15.6	15.5	15.4
16.7	16.6	16.5	16.4	16.3	16.2	16.1	16.0	17.7	17.6	17.5	17.4
18.7	18.6	18.5	18.4	18.3	18.2	18.1	18.0	19.7	19.6	19.5	19.4
20.7	20.6	20.5	20.4	20.3	20.2	20.1	20.0	21.7	21.6	21.5	21.4
22.7	22.6	22.5	22.4	22.3	22.2	22.1	22.0	23.7	23.6	23.5	23.4
24.7	24.6	24.5	24.4	24.3	24.2	24.1	24.0	25.7	25.6	25.5	25.4

Example 19:

The following code sequence draws the image in the picture

"D 00 00 00 00 V 0C 00 0D 00 7F 80 7F 80 60 C0 ... 60 60"

where "D 00 00 00 00" moves the cursor to the top left corner of the screen, "V 0C 00 0D 00" defines the 12x13 image, and the following bytes define the image. In this example the PutBitmap command is 1+2+2+13(12/8+1)=31 bytes long.*

4.22. GetBitmap command

Syntax: W (X size low) (X size high) (Y size low) (Y size high)

GetBitmap is a more complex and more powerful way of reading back the data displayed on the LCD screen than GetPixel. GetBitmap is capable of reading back all the data of a rectangular area. The command is five bytes long. The command code "W" is followed by the X and Y size of the area: W (X width low) (X width high) (Y height low) (Y height high). The SGI01 returns the data in a format similar to PutBitmap image format. See picture in PutBitmap.

Example 20:

The following code sequence reads back the image displayed by the PutBitmap example:

"D 00 00 00 00 V 0C 00 0D 00 H"

The SGI01 returns 26 bytes ("7F 80 7F 80 60 C0 ... 60 60").

4.23. DirectCommandWrite command

Syntax: a (command code)

This command instructs the SGI01 card to write the parameter byte to the command register of the LCD controller. SGI01 will perform the required busy checking. The command is two bytes long. The command code is "a" followed by the LCD command byte. The effect of the command depends on the controller type and mode. ***The use of this low level command is not recommended.***

Example 21:

The following code sequence changes the graphic home address of the T6963 to 500H allowing the use of split screen:

"b 00 b 05 a 42"

See Application Notes for the T6963C LCD Graphics Controller, Toshiba, August, 1991 or T6963C (Dot Matrix LCD Control LSI) Technical Data, Toshiba, 1991 for details.

4.24. DirectDataWrite command

Syntax: b (data byte)

This command instructs the SGI01 card to write the parameter byte to the data register of the LCD controller. SGI01 will perform the required busy checking. The command is two bytes long. The command code is "b" followed by the LCD data byte. The effect of the command depends on the controller type and mode. ***The use of this low level command is not recommended.***

4.25. DirectStatusRead command

Syntax: c

This command instructs the SGI01 card to read the status/command register of the LCD controller. SGI01 will perform the required busy checking. The read byte is available in the output FIFO of the SGI01. The command has no parameters. The command code is "c". The effect of this command depends on the controller type and mode. ***The use of this low level command is not recommended.***

4.26. DirectDataRead command

Syntax: d

This command instructs the SGI01 card to read the data register of the LCD controller. SGI01 will perform the required busy checking. The read byte is available in the output FIFO of the SGI01. The command has no parameters. The command code is "d". The effect of this command depends on the controller type and mode. ***The use of this low level command is not recommended.***

4.27. DirectChipselect command

`Syntax: e (select code)`

Some LCD with built-in HD61202 controller have two HD61202s on-board. To select between the two controllers use the DirectChipselect command. The command is two bytes long. The command code is "e". the select code is the following:

Description	Select code
Select controller #1	**"01"**
Select controller #2	**"02"**
Select both controllers	**"03"**

The use of this low level command is not recommended.

4.28. Echo command

`Syntax: x`

This command is used for testing the connection of the SGI01. When the SGI01 receives Echo command it returns the command code "x". The command has no parameters.

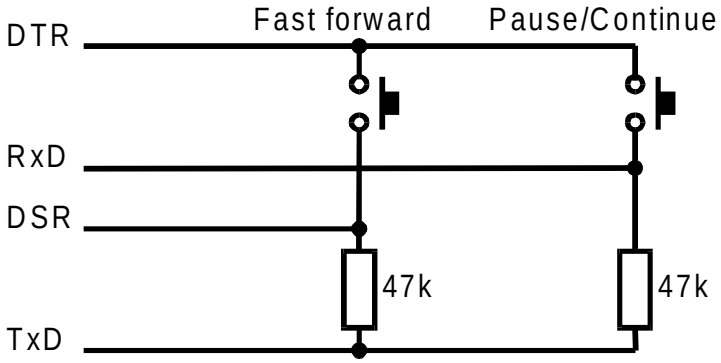
5. Built-in demo

There is a built-in demo available for the most commonly used LCDs. To select demo mode switch off SW1-8. The remaining DIP switches determine the controller type and the LCD size. See Appendix C.

If your LCD size is not listed, try to set a similar size. If the controller type and the single/dual switches are set correctly the demo probably works, though it is not guarantied.

5.1. Demo keys

It is possible to connect two keys to the RS-232 interface of SGI01 which work in demo mode as a PAUSE/CONTINUE and FAST FORWARD. The demo is stopped while the PAUSE/CONTINUE button is pressed and continue at normal speed when released. If the FAST FORWARD button is pressed the demo is running at the fastest possible speed. It is useful for finding a particular screen. The connection is the following:



The demo will work without these keys connected, but the time between pictures will be set to about one second.

6. Part numbering

There are two versions of SGI01:

SGI01A: 9-pin D type RS-232 connector

SGI01B: 2x5 pin RS-232 connector

Appendix A: DIP switch settings

Dipswitch	Description
1xxx xxx1	Serial line is used
0xxx xxx1	I²C interface is used
1000 0xx1	150 baud serial line
1001 0xx1	300 baud serial line
1010 0xx1	600 baud serial line
1011 0xx1	1200 baud serial line
1100 0xx1	2400 baud serial line
1101 0xx1	4800 baud serial line
1110 0xx1	19200 baud serial line
1111 0xx1	9600 baud serial line
1000 1xx1	38400 baud serial line
1001 1xx1	57600 baud serial line
1010 1xx1	115200 baud serial line
0000 xxx1	I²C write address 70H, read address 71H
0001 xxx1	I²C write address 72H, read address 73H
0010 xxx1	I²C write address 74H, read address 75H
0011 xxx1	I²C write address 76H, read address 77H
0100 xxx1	I²C write address 78H, read address 79H
0101 xxx1	I²C write address 7AH, read address 7BH
0110 xxx1	I²C write address 7CH, read address 7DH
0111 xxx1	I²C write address 7EH, read address 7FH
xxxx xx11	Switch Vee on/off
xxxx xx01	Do not switch Vee (Use for setting Vee only)
xxxx xxx0	Demo mode
xxxx x010	External T6963
xxxx x100	External HD61830
xxxx x110	External HD61202
xxxx 0xx0	Single screen
xxxx 1xx0	Dual screen
0000 xxx0	32x120
0001 xxx0	32x128
0010 xxx0	64x120
0011 xxx0	64x128
0100 xxx0	64x240
0101 xxx0	64x256
1000 xxx0	128x120
1001 xxx0	128x128
1010 xxx0	128x240
1011 xxx0	128x256

In the table 0=on, 1=off, x=irrelevant or defined elsewhere

Appendix B: Command summary

Command name	Command code
DefineLCD	A (LCD type) (LCD subtype) (size X low) (size X high) (size Y low) (size Y high)
SetMode	B (mode)
SetColor	C (color)
MoveTo	D (X low) (X high) (Y low) (Y high)
SetBacklight	E (on/off)
FillScreen	F
PutPixel	G
GetPixel	H
LineTo	I (X low) (X high) (Y low) (Y high)
Rectangle	J (X low) (X high) (Y low) (Y high)
FillRectangle	K (X low) (X high) (Y low) (Y high)
Circle	L (Radius low) (Radius high)
FillCircle	M (Radius low) (Radius high)
SelectFont	Q (font code)
SetTextAttribute	R (attribute code)
PutChar	S (character)
PutText	T <string> (00)
GetStringWidth	U <string> (00)
PutBitmap	V (X size low) (X size high) (Y size low) (Y size high) <image>
GetBitmap	W (X size low) (X size high) (Y size low) (Y size high)
MoveRel	Y (ΔX low) (ΔX high) (ΔY low) (ΔY high)
LineRel	Z (ΔX low) (ΔX high) (ΔY low) (ΔY high)
DirectCommandWrite	a (command)
DirectDataWrite	b (data)
DirectStatusRead	c
DirectDataRead	d
DirectChipselect	e (select code)
Echo	x